HUDSON-RARITAN ESTUARY
ENVIRONMENTAL RESTORATION FEASIBILITY
STUDY

ARTHUR KILL/KILL VAN KULL

STUDY AREA REPORT

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U.S. Army Corps
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TABLE OF CONTENTS

I. INTRODUCTION 1

BACKGROUND 1

STUDY AREA DELINEATION OF THE ESTUARY 2

PURPOSE OF THE STUDY AREA REPORTS 2

FORMAT OF THE REPORT 3

II. STUDY AREA DESCRIPTION 4

SETTING 4

STUDY AREA HISTORY 4

HISTORY OF DEGRADATION 5

EXISTING LAND/WATER USAGE 7

NATURAL RESOURCES CONDITIONS 8

III. ECOSYSTEM RESTORATION 11

HUDSON-RARITAN ESTUARY ECOSYSTEM 11

PRIMARY RESTORATION NEEDS OF THE HUDSON-RARITAN ESTUARY 12

RESTORATION NEEDS OF THE ARTHUR KILL/KILL VAN KULL STUDY AREA 12

Wetland Protection and Restoration 13

Restore Stream/River Habitat 14

Restore and Enhance Nesting Habitat for Colonial Waterbirds 14

Remediate Leachate Sources and Persistent Oil Spill "Hotspots" 14

Contaminated Sediments 14

Restore/Remediate Brownfield Sites 15

EXISTING RESTORATION EFFORTS 16

Prall's Island 16

Rahway River Flood Plain Restoration 16

Rahway River Ecosystem Restoration Study 16

Chelsea Bridge 17

Saw Mill Creek 17

Woodbridge River *17*
POTENTIAL RESTORATION SITES 18
IV. CONCLUSIONS 20
V. REFERENCES 21

LIST OF TABLES

Table 1 – Potential Restoration Sites in the Arthur Kill/Kill van Kull 19

LIST OF FIGURES *(end of text)*

Figure 1 HRE Study Area
Figure 2 Location Map of Arthur Kill/Kill van Kull Study Area

ARTHUR KILL/KILL VAN KULL

STUDY AREA REPORT

I. INTRODUCTION

Background

1. The New York District of the Corps of Engineers (the District) is conducting a feasibility study for ecosystem restoration in the Hudson-Raritan Estuary (the Estuary) – the Hudson-Raritan Estuary Ecosystem Restoration Study, herein referred to as "HRE". The study area is delineated as the Port District, an area surrounding greater metropolitan New York City within an approximate 25-mile radius of the Statue of Liberty (Figure 1). However, for purposes of ecological continuity the actual study area may include additional portions of this system beyond the man-made Port District boundary.

2. The overall goal of the HRE is to restore ecological function and diversity that have been lost or degraded as a result of human activities. The HRE will rely on both existing and newly obtained natural resource data to identify areas to be restored or conditions that must be addressed to assure successful ecosystem restoration. The two primary components of the study are the preparation of a Comprehensive Restoration Implementation Plan (CRIP) and the implementation of restorations/enhancements at various locations in the Estuary.

3. The purpose of the CRIP is to serve as a master plan that lays out a comprehensive and coordinated strategy that, when implemented, will guide the ecological restoration of the Estuary. The CRIP will establish a framework within which the actions needed for successful restorations can be holistically evaluated and planned. The plan will address actions to enhance, expand, recreate, and diversify natural habitats, and actions to eliminate constraints to ecological functions, such as sediment contamination. The CRIP will describe the strategy for restoration efforts that will include immediate, mid-term, and long-range options. It will also provide a central focus for public input, data collection, restoration efforts, and management actions and policies, regardless of who might have authority, desire and/or funds to undertake any action.

Study Area Delineation of the Estuary

4. To get a more manageable and understandable picture of the Estuary, its history of degradation, local needs and desires, potential restoration opportunities, and current restoration efforts will be documented in eight Study Area Reports (SARs). The study area boundaries are typically delineated by major watersheds and/or major physical features, such as highways or waterways. By and large, each study area can be characterized by its ecological functions, history of degradation, and resulting needs and opportunities. For example, Jamaica Bay, a historically expansive wetlands complex, has been subject to extensive fill and loss of wetlands; the Hudson River system, to hardened shorelines and contaminated sediment; and the Lower Bay contains coastal and offshore environments, experiencing loss of dunes and benthic habitat. Separating the project area into smaller study areas will enable the study team and potential stakeholders to address study area-specific restoration needs as well as individual restoration opportunities within each study area, and to collect and characterize data in a more usable and understandable way, all under the ultimate umbrella of the CRIP, which links the study areas into one major plan.

5. The eight study areas to be included in the CRIP are as follows (see Figure 1):

1) Jamaica Bay,
2) Lower Bay,
3) Lower Raritan River,
4) Arthur Kill/Kill van Kull,
5) Newark Bay/Hackensack River/Passaic River,
6) Lower Hudson River,
7) Harlem River/East River/Western Long Island Sound,
8) Upper Bay.

Purpose of the Study Area Reports

6. The identification of potential restoration opportunities in each study area will be a two-fold process. First, the District will identify potential restoration sites based upon a preliminary needs and opportunities survey of various interested groups/agencies conducted by the Regional Planning

Association (RPA) and presented in their Needs and Opportunities Report. This information will be supplemented by additional analyses of restoration needs and opportunities on a more local level. Study area needs will be determined based upon the causes of ecosystem degradation and the condition of existing natural resources in each study area. This effort is already underway (but far from completed) and potential restoration sites in the Arthur Kill/Kill van Kull study area have been identified.

7. Second, the District will hold stakeholder meetings in each study area. The purpose of these meetings will be to incorporate additional comments from environmental organizations, community groups, and other individuals and stakeholders in each study area. This process will ensure the needs and opinions of as wide and diverse a group as possible are incorporated into the CRIP.

Format of the Report

8. This SAR addresses the Arthur Kill/Kill van Kull study area (Figure 2). The **Study Area Description** section describes the setting, history of degradation, existing land/water usage, and existing natural resources in the study area. Restoration needs and existing restoration efforts are summarized in the **Ecosystem Restoration** section.

II. STUDY AREA DESCRIPTION

Setting

9. The Arthur Kill connects Newark Bay to Raritan Bay. The study area includes a large portion of northern and western Staten Island, New York, and the municipalities of Clark, Carteret, Linden, Rahway, Scotch Plains, Union, Westfield, and Woodbridge in Middlesex and Union Counties, New Jersey (Figure 2). Major tributaries in the study area include the Elizabeth River, the Rahway River, and Fresh Kills. The study area also includes a portion of the Kill van Kull, which connects the Arthur Kill to the Hudson River and the Upper Bay.

10. The New Jersey Department of Environmental Protection (NJDEP) has designated watershed management areas throughout the state. The Arthur Kill/Kill van Kull study area, as defined by this Study Area Report, is located within Watershed Management Area (WMA) 7.

Study Area History

11. Major changes to the natural landscape within the study area began with European settlement. The earliest settlements were primarily agricultural settlements located a short distance inland from the waterway. Trees cleared for agriculture were used for fuel, building materials, and charcoal. Hay from marsh grasses, along with other agricultural products, was transported to Manhattan for sale. Important early industries in the study area included clay mining, brick productions, and linoleum manufacturing. Shipping was the primary mode of transportation used to export agricultural and industrial products from the study area; however, the extensive salt marshes along the waterfront made access for ships difficult. As a result, many of the marshes were filled and bulkheaded and piers and wharfs were built (Hatch Mott MacDonald 2003a).

12. The arrival of the railroad allowed the study area to further develop as an important center of industry and commerce. This resulted in the establishment of the petroleum and chemical industries along the waterfront of the Arthur Kill, Kill van Kull, and the Hudson River. In the late 19th and early 20th centuries, residential development expanded in the study area, resulting in a further reduction of agricultural land. Eventually, agricultural land in the study area was almost completely replaced by residential, industrial, or commercial development. (Hatch Mott MacDonald 2003a).

History of Degradation

13. Today, the study area contains high concentrations of industrial facilities, including oil refineries, chemical and plastics manufacturers, and petroleum distribution facilities. Because of its importance as an industrial center and shipping port, waterways in the study area were dredged from a depth of less than 16 feet to over 40 feet in some areas, with an average depth of 30 feet. Approximately 45 percent of the shoreline has been bulkheaded or rip-rapped.

14. Prior to the inception of the Clean Water Act in 1972, many of the industrial facilities in the region released toxic contaminants into local waterways. As a result, toxic substances including polychlorinated biphenyls (PCBs) and heavy metals have accumulated in much of the bottom sediments within the Arthur Kill, Kill van Kull, and other waterbodies in the study area. Many of the toxic contaminants discharged into the waterways of the study area are persistent chemicals that do not easily breakdown. As a result, these toxins accumulate through the food chain in the tissues of plants, invertebrates, fish, and birds that reside in or move through the area.

15. The contamination of both marine sediments by chemical pollutants and heavy metals, and the resulting spread of those materials through aquatic and terrestrial food chains have been recognized as key environmental problems in the Estuary. Numerous studies of the problems have been undertaken by various organizations and agencies, including the Environmental Protection Agency, the National Oceanic and Atmospheric Administration (NOAA), the USACE, and the States of New York and New Jersey, which have focused on the relationship between sediment contaminant levels and benthic habitat quality. Previous studies have identified areas within the Arthur Kill/Kill van Kull study area containing high levels of arsenic, chromium, cadmium, and mercury. More detailed discussions and results of past and current studies of sediment contamination are described in the more detail in the *Summary of Sediment Characterization Studies* (USACE – under development).

16. As a major hub for the petroleum industry in the northeast United States, the study area contains a large number of refineries and storage facilities. Historically, a number of oil spills have had direct impacts on natural resources. In 1990, over one million gallons of oil were spilled into the Arthur Kill and Kill van Kull. This figure represents nearly 70 percent of all the oil spilled in New York Harbor that year (USFWS 1997).

17. The Arthur Kill/Kill van Kull study area has been an urban population center since the middle of the 19th Century (NY City Dept. of Planning 2003). The area has a current population density that is 75 times higher than the national average and estimates indicate there are more than 6,000 people per square mile (USFWS 1997). The high population density has resulted in both historic and present-day impacts to water quality. Historic discharges of sewage led to the presence of pathogenic bacteria and low dissolved oxygen levels. In more recent years, urban runoff, wastewater discharges, and combined sewer overflows (CSOs) have contributed to water quality problems associated with low dissolved oxygen levels, pathogenic bacteria, household chemicals, and floatable debris.

18. Numerous closed landfills exist in the study area, including the Fresh Kills Landfill on the western shore of Staten Island. Historically, landfills contributed to water quality problems through contaminated leachate, which was a result of poor initial construction or improper closure. To remedy impacts to water quality, leachate recovery systems have been installed at many landfills, including the Fresh Kills Landfill.

19. Although the study area is highly urbanized, many small areas of natural shoreline, wetlands, and upland habitat still remain. However, in many cases, these natural habitats are degraded due to past human use, invasion by non-native species, channel deepening impacts, or long-term erosion. For example, many tidal wetland areas have seen their water flow or tidal regimes severely altered and elevations raised by fill creating conditions that force out native species and encourage invasive species such as common reed (*Phragmites communis*) and tree-of-heaven (*Ailanthus altissima*); invasive species that often constitute a lower quality wildlife habitat. Continuous erosion is a problem in the study area due to the wave energy generated as a result of vessel traffic. Tide gates, dams, or debris block fish passage on some tributaries.

20. Distanced from the historic shipping center of New York Harbor, the Arthur Kill/Kill van Kull study area has become the port's ship graveyard. The Arthur Kill contains approximately 275 derelict vessels of various sizes located within five crowded vessel graveyards along the Staten Island shoreline. These vessels are distributed from the shallows to upland areas adjacent to the shoreline. Also located all along the waterway as well as interspersed throughout the vessel

graveyards are dozens of abandoned wooden piers. These vessels and piers continue to deteriorate and break up, becoming of the source of waterborne drift material. The presence of these vessels and piers has replaced the natural tidal ecosystem with an artificially shallow, albeit often unsightly, tidal system, providing, in addition to natural areas, supplemental nesting, resting, shade, shelter, and feeding opportunities. The collection and removal of this drift material is the subject of the District's *New York Harbor Collection and Removal of Drift Material (*LRR dated 1999*).* The intent of that project is to remove the material, often only to the mudline, to eliminate drift sources. The removal of the potential drift material also helps restore the areas to tidal wetlands or natural shorelines.

Existing Land/Water Usage

21. Dominant land uses within the study area are residential and industrial. The waterfront of the Arthur Kill is characterized by a dense concentration of industrial uses, including port facilities, and petroleum and chemical industries. Many abandoned industrial facilities also exist along the waterfront, primarily in the southern reaches.

22. Water is withdrawn from the Arthur Kill and used as cooling water at the Sewaren, Linden, and Arthur Kill power plants. Three sewage treatment plants (STPs) discharge treated wastewater in the study area: Joint Meeting of Essex and Union Counties, Linden-Roselle Sewerage Authority, and Rahway Valley Sewerage Authority. Groundwater leachate is also discharged to the Arthur Kill from closed landfills (31 located in Essex and Union counties), the closed Fresh Kills Landfill, and dozens of brownfields and contaminated sites.

23. Despite the presence of abandoned industrial sites and numerous vessel graveyards, the study area remains a busy shipping port with commercial ship and barge traffic as the dominant water use, especially in the upper reaches where it joins the Kill Van Kull. Secondary water uses, although generally minimal, include non-contact recreation, such as fishing and boating. However, due to high concentrations of toxic substances fish consumption advisories have been issued for blue crab, striped bass, bluefish, American eel, white perch, and white catfish. Though none of the tributaries to the Arthur Kill are considered suitable for swimming, individuals have been observed wading or swimming in the Arthur Kill and its tributaries.

24. Beyond the waterfront, land use includes typical residential, commercial, and industrial uses. Although the study area is generally characterized by vast expanses of developed lands, some public parks and open space exist. Within the New Jersey portion of the Arthur Kill watershed, approximately 8,000 acres have been preserved as parkland. Additionally, the New York City Department of Planning is currently preparing a Master Plan for the Fresh Kills Landfill in Staten Island with the intent of reclaiming the landfill for public use (NYC Department of Planning 2003). The landfill was closed in March 2001 and is now undergoing extensive remediation. Portions of the landfill may be available for public use as early as 2008.

Natural Resources Conditions

25. The natural resources of the Arthur Kill/Kill van Kull study area have been significantly altered due to nearly 200 years of intense human activity. As a result of urbanization and industrialization, many surface waterbodies are considered impaired because of elevated levels of toxic substances and/or low levels of dissolved oxygen. Water quality impairments are due to sewage treatment plant discharges, CSOs, industrial discharges, urban runoff, petroleum spills, and ship/barge traffic. Concentrations of heavy metals and organic compounds are high in the bottom sediments in the study area, particularly in the Arthur Kill. These contaminated sediments are the result of industrial discharges coupled with slow flushing rates. The Arthur Kill functions as a sediment sink because it receives and accumulates toxic substances from contaminated, upstream sites, carried to the deeper, slower moving water body by faster moving streams, rivers and brooks.

26. At least 16 tributaries flow into the Arthur Kill (RPA 2003). Freshwater tributaries have the potential to provide spawning habitat for anadromous fish such as striped bass (*Morone saxitilis*) and alewife (*Alosa pseudoharengus*). However, in many cases, debris dams, tidegates, and other structures block fish passage. For example, a dam on Richmond Creek (a tributary to Fresh Kills on Staten Island) prevents anadromous fish from reaching potential upstream, freshwater spawning habitat. This dam also blocks passage for the catadromous American eel (*Anguilla rostrata*), which spends its adult life in freshwater. Juveniles of this species have been documented crawling over the Richmond Creek Dam during their upstream migration to freshwater (American Littoral Society 1993).

27. The landscape of the study area was once dominated by tidal and freshwater wetlands located along the Arthur Kill and its many tributaries. As a result of extensive development, approximately 45 percent of the natural shorelines have been hardened or filled by bulkheads or riprap (USFWS 1997). Areas where natural conditions remain are still generally characterized as tidal wetlands; however, in the New Jersey portion of the Arthur Kill/Kill van Kull study area, only about 4 percent of the land remains as wetlands (Hatch Mott MacDonald 2003).

28. Habitat conditions in most of the remaining wetlands are degraded. In 1998, the District studied a sample group of wetlands in the study area. Approximately 40 percent of the wetlands surveyed were dominated by monotypic stands of common reed (USACE 1998). Common reed is an invasive species that is able to out-compete native vegetation to form dense monotypic stands, especially in disturbed environments. Wetlands dominated by invasive species are considered to have reduced ecological value because these species tend to out-compete native vegetation thereby reducing native plant species diversity (Mitsch and Gosselink 2000). Additionally, dense stands are considered to provide reduced forage and cover to wildlife. Some wetlands and tributaries in the study area are further degraded due to accumulations of floatable debris, harbor drift, and derelict vessels. In other areas, wetlands are eroding as a result of high wave energy caused by heavy vessel traffic in the study area.

29. Human disturbance in the study area has had some beneficial affects. Shooter's Island, Prall's Island, and Isle of Meadows are upland islands comprised primarily of dredged material and fill. Collectively referred to as the "Harbor Herons Complex", these islands form the largest heronry in New York State. They also account for 25 percent of the wading birds that breed in coastal New Jersey, New York, and Connecticut (USFWS 1997). Nine species of wading birds including black-crowned night herons (*Nycticorax nycticorax*), snowy egrets (*Egretta thula*), great egrets (*Ardea alba*), cattle egrets (*Bulbulcus ibis*), glossy ibis (*Plagidis facinellus*), and yellow-crowned night heron (*Nyctanassa violacea*) nest in the Harbor Herons Complex; however, in recent years breeding populations on the islands have declined. The wading birds are thought to be abandoning the islands because tree-of-heaven, a non-native and invasive species, is replacing native tree species that were once dominant (HEP 2001). Native species, particularly gray birch (*Betula lenta*), are the preferred nesting substrate of wading birds (HEP 2001).

30. Islands in the study area also provide nesting habitat for gulls and terns, which generally nest on the ground in open areas characterized by sparse, low-growing vegetation (Baicich and Harrison 1997). Common reed is encroaching on many suitable nesting areas on the islands, thereby reducing the amount of habitat available to this group of species for nesting.

31. Natural wetland habitats that remain in the study area include tidal marshes, freshwater marshes, wooded swamps. Tidal and brackish wetlands are dominated by smooth cordgrass (*Spartina alterniflora*) and salt meadow cordgrass (*Spartina patens*), spike rush (*Distichlis spicata*), marsh elder (*Iva frutescens*), common reed, and cattail (*Typha latifolia*). Marshes with more freshwater inputs are characterized by species including pondweed (*Potamogeton* spp.), spatterdock (*Nuphar variegatum*), and pickerelweed (*Pontedaria cordata*). In some places, scrub-shrub wetlands exist adjacent to marshes. Species present in these habitats include dogwoods (*Cornus* spp.), mulberry (*Morus* spp.), alder (*Alnus* spp.), and buttonbush (*Cephalanthus occidentalis*). Tree species present in forested freshwater wetlands include red maple (*Acer rubrum*), sweet gum (*Liquidambar styraciflua*), and swamp white oak (*Quercus bicolor*). Understory species present in the forested wetlands include spicebush (*Lindera benzoin*) and skunk cabbage (*Symplocarpus foetidus*). Although natural areas remain, they are highly fragmented due to the intense industrial, residential, and commercial development.

32. Remnant patches of undisturbed wetland and upland habitat include regionally-rare vegetative communities that include southern and coastal plant species like native persimmon (*Diospyros virginiana*), blackjack oak (*Quercus marilandica*), sweet bay (*Magnolia virginiana*), and a population of southern leopard frogs (*Rana sphenocephala*). These habitat patches are important for landbirds, including Neotropical migrant songbirds because they provide small areas of natural habitat for resting, foraging, and breeding in an otherwise urbanized landscape. Although these habitat patches can be important to many species of wildlife, their small size and isolation from one another reduces their habitat value for some groups of species, such as forest-nesting birds.

III. ECOSYSTEM RESTORATION

Hudson-Raritan Estuary Ecosystem

33. The New York-New Jersey Harbor Estuary Program (HEP 1996) has identified five primary factors that have caused ecosystem impairments or otherwise degraded water or habitat quality in the Estuary. These factors are:

- Habitat Loss and Degradation: Recent wetland inventories estimate at least 80% of the Estuary's wetlands have been lost or significantly altered.

- Toxic Contamination: The presence of toxins in the Estuary's waters, sediments, and biota is the result of historic and residual contamination by industrial and non-point sources. Today, wastewater discharges, CSOs, accidental releases, vehicle exhaust emissions, household chemicals, pesticides, atmospheric deposition, landfill leachate, urban runoff, and other non-point sources are continuing sources of toxic substances (HEP 1996).

- Pathogens: The primary sources of pathogens include CSOs, sewage treatment plant malfunctions, illegal connections to storm sewers, vessel sewage discharge, urban runoff, and other non-point sources.

- Floatable Debris: Floatable debris is made up of two primary components: trash or litter and harbor drift. Trash and litter enters the Estuary via runoff, storm sewer discharges, CSOs, beach and boat litter, and poor solid waste handling operations. Harbor drift composed primarily of material from dilapidated shoreline structures such as piers, bulkheads, and pilings, is a significant problem in the Estuary.

- Nutrient and Organic Enrichment: Eutrophication due to excessive discharges of nitrogen is a significant problem in the Estuary. Organic matter comprised primarily of carbon is decomposed as DO and used in the biochemical process. Nitrogen and carbon enter the Estuary through point and non-point sources such as sewage treatment plants, runoff (primarily from over-fertilized lawns), rivers and tributaries and atmospheric deposition.

Primary Restoration Needs of the Hudson-Raritan Estuary

34. The overall goal of the HRE is to restore and enhance aquatic and nearshore terrestrial habitats that have been lost or degraded as a result of human activities. To achieve this goal, primary restoration needs of the Estuary have been established. These categories were identified in the document entitled *Restoration Opportunities in the Hudson-Raritan Estuary* (USACE 2001) These needs are:

- Restore and create intertidal wetlands and mudflats,
- Restore benthic habitats and remediate "hot spots" of contaminated sediments,
- Restore and create freshwater/riparian wetlands,
- Restore fish habitat (remove impediments to fish passage; construct artificial reefs),
- Restore shellfish habitat,
- Restore and enhance shoreline/coastal fringe habitat (including upland areas),
- Create, restore, or enhance vegetated and non-vegetated shallow water habitat.

Restoration Needs of the Arthur Kill/Kill van Kull Study Area

35. Despite the intense industrialization and urbanization, the Arthur Kill/Kill van Kull study area is an important ecological component of the Estuary. The study area contains important nesting habitat for herons and other colonial nesting waterbirds. The USFWS (1997) considers the study area a significant habitat complex within the Southern New England-New York Bight. Based upon the values of the study area as well as the conditions of the existing resources, specific restoration needs within the Arthur Kill/Kill van Kull study area include:

- To return hardened shorelines to more natural conditions,
- To remove derelict vessels and deteriorating piers,
- To reduce erosion of natural areas exposed to waves from to vessel wakes,

- To improve sediment quality by removing, treating, and or capping contaminated sediments.

- To improve water quality through reductions in leachate, and pollutant runoff and discharge.

36. The specific restoration needs may be met through existing, ongoing, and future ecosystem restoration efforts in the study area, as discussed below.

Wetland Protection and Restoration

37. The Arthur Kill/Kill van Kull study area has experienced significant losses of coastal wetlands. Restoration of tidal salt marshes in the upper reaches may not be viable because wave energy causes significant erosion of unstable sediments. In these areas, measures to protect wetlands from further degradation could be implemented. For example, wave dissipation and tenser fences could be installed along marsh edges and debris could be removed from existing mudflats and wetlands.

38. Many marshes along tributaries to the Arthur Kill (e.g., Woodbridge Creek) may offer opportunities for salt marsh restoration because erosion associated with commercial boat traffic is reduced. Degraded salt marshes and freshwater wetlands can be restored by removing fill, recontouring the ground surface, and planting native wetland vegetation.

39. Abandoned navigation channels and waterfront areas may offer opportunities for restoration projects. Along the waterfront, bulkheads at abandoned industrial sites could be removed and the shoreline could be recontoured to more natural conditions. Clean dredge material could be used to create natural shoreline contours that transition from tidal mudflats to low marsh and eventually to high marsh and uplands.

40. Wetland protection and restoration in the study area is important for several reasons. These efforts will provide additional nursery habitat for fish and foraging habitat for wading birds, gulls, and terns. Many of the birds that nest in the Harbor Herons Complex rely on wetlands in the Arthur Kill/Kill van Kull study area as a source of food.

Restore Stream/River Habitat

41. There is a need to restore stream and river habitat within the study area. This could be achieved by removing debris and structures that restrict tidal flow and fish movement. Fish ladders could be installed in areas where structures cannot be removed. Riparian habitat along many of the streams and rivers has been greatly reduced. Floodplain restoration efforts could be included in projects that involve restoration of stream and river habitat. Removal of fill and planting of native floodplain vegetation could help improve water quality, reduce flooding, and provide wildlife habitat.

Restore and Enhance Nesting Habitat for Colonial Waterbirds

42. As noted earlier in the report, the Arthur Kill/Kill van Kull study area contains several large heron rookeries and habitat for other colonial nesting waterbirds such as gulls and terns. In recent years, nest success has decreased in the heron rookeries and there is concern that the birds may abandon some nesting sites. Therefore, an important restoration need for the study area is to restore and enhance remaining nesting habitat for colonial waterbirds. Heron and egret nesting habitat can be improved through efforts such as the removal of invasive species and planting of native species preferred for nesting. Removing common reed in areas of fill and depositing sand or shell could create nesting habitat for habitat for gulls, terns, and black skimmers (*Rhynchops niger*). Overall nest success could be improved through the removal of feral predators on some islands.

Remediate Leachate Sources and Persistent Oil Spill "Hotspots"

43. Efforts should be made to identify and remediate leachate sources and persistent oil spill "hotspots." Leachate recovery and treatment systems could be installed to treat contaminated leachate from former landfills and industrial sites where groundwater contamination contributes to water quality problems. Identification and remediation of persistent oil spill "hotspots" could eliminate continuous sources of petroleum pollution in the study area.

Contaminated Sediments

44. Contaminated bottom sediments are a significant problem in the study area. Some areas are "sources," which contribute to contamination of other areas when the sediments are transported by

littoral currents. Other areas are "sinks" for contaminated sediments. These "sinks" accumulate contaminated sediments that are moved by the currents within the waters of the study area. These contaminated sediments effect not only the immediate area but spread throughout the system through resuspension and natural dispersion. Several options exist for the remediation of contaminated sediments. One potential option is to cap areas of contaminated sediments using clean material. Another option is to remove the contaminated sediments by excavating or dredging them and replacing the sediments that were removed with clean material.

45. Because of the ongoing deepening of many navigation channels in the area, there is an especially good opportunity to have available millions of cubic yards of good quality dredged material for capping in an especially cost-effective manner. However, this material will only be available over the next 10 years, so plans to take advantage of this limited opportunity must me expedited to maximize clean-up of this area-wide problem.

46. Contaminated sediments that are removed from waterbodies in the study area could be treated or decontaminated and then used beneficially to cap other landfills/brownfields, restore mines, provide a structural base for infrastructure, or even manufacture useful products such as concrete mix, glass, etc.

Restore/Remediate Brownfield Sites

47. Many abandoned industrial and commercial facilities (also referred to as "brownfield sites") are present in the study area. Contamination at existing brownfield sites could be remediated and the sites restored to more ecologically viable conditions. Abandoned, man-made structures could be removed and native vegetation could be re-established. In addition, depending upon their position in the landscape, brownfield sites could be used to establish buffers between existing industrial or residential uses and natural communities. Restoration of brownfield sites could also result in the development of a greenway system that connects isolated patches of remnant habitat as described in the Existing Natural Resources section.

Existing Restoration Efforts

48. Numerous habitat restoration projects have been undertaken in the study area and various organizations, most notably, the Harbor Estuary Program (HEP) Habitat Workgroup, have identified additional potential sites and sought to promote protection and restoration efforts. The following habitat restoration initiatives have been completed or are moving forward in this study area.

Prall's Island

49. Prall's Island is a small island located in the central portion of the Arthur Kill. The island is a former salt marsh that was created by the placement of fill on marsh sediments. As a result, the land area is dominated by common reed. The heron rookery is dominated by tree-of-heaven, which is also a non-native, invasive species. Tree-of-heaven replaced gray birch as the dominant overstory species. As a result, the number of herons nesting on Prall's Island has decreased. Therefore, the New York City Department of Parks, Natural Resources Group has completed some restoration efforts on Prall's Island to enhance habitat for nesting wading birds. This could serve as a model to expand such efforts on the island and to other islands in the area.

Rahway River Flood Plain Restoration

50. The NY/NJ Baykeeper formed a partnership with NOAA and numerous other local, state, and federal agencies to restore and enhance 4.5 acres of riparian wetlands along the Rahway River in Union County, New Jersey. The restoration was accomplished by purchasing flood prone properties and removing fill from an area that was historically a riparian wetland. To date, 1.6 acres of wetlands were restored through the removal of fill. In these areas, native vegetation was planted and vegetated buffers were established. In addition, 0.16 acres of degraded forested wetlands were enhanced. The USEPA estimates that over 2,000 cubic yards of fill was removed from the site.

Rahway River Ecosystem Restoration Study

51. The District is currently completing a draft Environmental Restoration Report for an ecosystem restoration project on the west bank of the Rahway River, just north of the Milton Avenue Bridge in the City of Rahway, Union County, New Jersey. Accelerated loss of wetland and riparian habitat

has occurred at this location. The plan for this site includes restoring and enhancing wetland habitat to increase the ability of the area to function as a tidally influenced riparian marsh ecosystem.

Chelsea Bridge

52. The Chelsea Bridge restoration project is located on Saw Mill Creek at the Chelsea Road Bridge, in Staten Island, New York. In 1998, the NYC Department of Parks acquired 5,550 smooth cordgrass (*Spartina alterniflora*) plugs and 2,350 salt meadow cordgrass (*Spartina patens*) plugs for the project. Original restoration plans called for the plants to be placed in a specific excavated area. Upon excavation, a large debris field was discovered. This debris field rendered nearly two-thirds of the site unacceptable for planting. Other portions of the site were made suitable for planting by placing sand over unsuitable planting substrate. The NYC Department of Parks is currently monitoring vegetation growth at this site.

Saw Mill Creek

53. Saw Mill Creek is located on Staten Island, within the 111-acre Saw Mill Creek Preserve. An earthen dike constructed as part of a land reclamation project once restricted tidal flow to a 12-acre portion of the marsh. As a result, common reed has overtaken the area. In July 1999, the NYC Department of Parks removed a 750-foot section of the dike and planted salt meadow cordgrass at the site. A five-year monitoring program is currently underway at this site.

Woodbridge River

54. Two ecosystem restoration projects along the Woodbridge River are currently in the early planning phases. The NJDEP Office of Natural Resource Damages is planning the restoration of 25 acres of salt marsh. Funding for the restoration design was obtained by damage claims recovered from the 1990 Exxon oil spill that occurred in the Arthur Kill. Woodbridge Township will obtain funding for construction. The project plans include reconnecting the site with the larger estuary and building an environmental education facility with a classroom and nature trails.

55. The second Woodbridge River project is a flood control project with an ecosystem restoration component. The project area is five miles in length and encompasses an area of 10 square miles.

Other waterbodies included in the project are Heards Brook, Wedgewood Brook, and Spa Spring. For this project, the District is considering a number of different control solutions such as property buy-outs, elevating structures, flood proofing buildings, and constructing levees. The District is currently evaluating four potential sites for ecosystem restoration. The project is in the scoping phase and the District's coordination with local, county, state, and federal agencies has commenced to identify issues and concerns.

Potential Restoration Sites

56. Thirty potential restoration sites have been identified in the Arthur Kill/Kill van Kull study area and are listed in Table 1. Each site will be evaluated to determine which of the proposed restoration activities, if any, are feasible from an engineering and economic perspective. Also of special interest are sites that offer opportunities to connect and/or expand existing high-quality areas or create habitats that are in especially short supply or have suffered disproportionate losses in the past.

Table 1 – Potential Restoration Sites in the Arthur Kill/Kill van Kull

HRE Site ID	Name	Restoration Opportunities[(1)]
1AK	Rahway River/Orange Reservoir	8
2AK	Rahway River/Cranford	4,8
3AK	Rahway River/Vauxhall Creek	4,8
4AK	Rahway River Parkway/The Lagoon	3,8
5AK	Rahway River/Parkway Lake	7,8
6AK	Rahway River/Union/Allen Streets	3,8
7AK	Rahway River/West Grand Avenue	4,8
8AK	Rahway River/Essex Street	3,4,8
9AK	Rahway Riverfront Park	1
10AK	Rahway River/Madison/Maples Avenues	8
11AK	Rahway River/Central Avenue (RHR)	8
12AK	Rahway River/Joseph Medwick Park	3
13AK	Rahway River/Central Avenue (RHE)	8
14AK	Range Road Forest	1
15AK	Rahway River	1,3,4,6
16AK	Rahway River/DRI-Print Foil Printing Co.	8
17AK	Rahway River/Milton Lake	4,7,8
18AK	Rahway River/Potters Island	6
19AK	Elizabeth River	1,3,4,6
20AK	Arthur Kill Multiple Sites	1
21AK	Bridge Creek Stream Corridor-Howland Hook Container Port	8
22AK	Morses Creek	1,4
23AK	Shooters Island	1,6
24AK	Piles Creek	1,4
25AK	Old Place Creek/Arthur Kill/Kill Van Kull	1,2,3,4,6
26AK	Pralls Island	1,6
27AK	Kill Van Kull/Van Kull A&B	9
28AK	Fresh Kills Landfill	6
29AK	Richmond Creek	4
30AK	Woodbridge Creek	1,6
31AK	Woodbridge River	1,6,7,8
32AK	Long Pond Park	8,9

(1) Restoration Opportunities:
1 – Restoration/Creation of Intertidal Wetlands/Mudflats
2 – Benthic Habitat Restoration (Hotspot Removal)
3 – Restoration/Creation of Freshwater/Riparian Wetlands
4 – Restoration of Fishery Habitats (Anadramous Fish Migration, Artificial Reefs)
5 – Shellfish Habitat Restoration
6 – Restoration/Enhancement of Shoreline/Coastal Fringe Habitat (Dunes, Bird Habitat)
7 – Creation/Restoration/Enhancement of Shallow Water Habitat (including Eelgrass)
8 – Shoreline Enhancement/Bank Stabilization
9 – Water Quality Improvement
10 – Riparian Habitat Restoration
11 – Environmental Interpretation
* To be determined

IV. CONCLUSIONS

57. The Arthur Kill/Kill van Kull study area has a unique combination of problems that have led to the current degraded state of the natural resources. Hardened shorelines, heavy industry, sediment contamination, and wetland loss have degraded water quality and habitat conditions. Therefore, the primary restoration needs in the study area should focus on the restoring degraded/hardened shorelines to a more natural setting, remediation of contaminated sites, and enhancement of the habitats that remain. Beneficial use of dredged material can greatly assist in meeting these needs and a unique opportunity exists to do so because of the volumes of material planned for removal to deepen the Arthur Kill, Kill van Kull, and Newark Bay channels over the next 10 years. This material could be used to cap contaminated sediments and create additional wetland habitat in abandoned channels and waterfront areas. Abandoned brownfield sites also offer unique opportunities for ecosystem restoration. Restoration could return abandoned sites to viable habitat for fish and wildlife and provide opportunities for public access to the waterfront for recreational activities.

58. Restoration can be accomplished through partnerships between Federal, state, and local governments and agencies. For example, the District and other local sponsors may cap contaminated sediments or restore wetland areas in the study area. Where degradation or contamination is related to issues such as Superfund sites, CSOs, or brownfields, the responsible parties, facility operators, or other private entities may lead restoration or remediation efforts.

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FIGURES